

## STRENGTH TEST OF SERRATED BEAM FOR ARMOR LAYER BREAKWATER

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**ABSTRACT:** In line science and technology developments is absolute inshore zone developed to meet human needs, both for transportation and for support of tourism and residential areas, planning a coastal structures must have a high level of security and economic character, so in planning coastal structures thing to consider is the availability of sufficient material for the construction, so that the construction can be carried out strong and economical. Along with a reduction the large stone for breakwater construction the human trying to switch an artificial stone made from concrete and formed in accordance with the concept of the researched, but for areas that lack a concrete manufacturing resource sufficient then this would be a separate issue that required design expected to utilize local materials and reduce the amount of cement.

**Keywords:** Construction, economic, breakwater, local material

### INTRODUCTION

In line with the development of science and technology is an absolute inshore zone developed to meet human needs, both for transportation and for support of tourism and residential areas, in the development of these problems often faced by high waves so we need a safety to support the construction of the development to fit expected in the planning. One of the buildings in the development of coastal areas that could cost pretty high fee is the breakwater, the building was constructed to provide protection against the shore from wave attack, so the beach can be safe from abrasion. Planning of coastal structures must have a high level of security and is economical. so in planning coastal structures must be aware of is the availability of sufficient material for construction, so construction could stand strong and economical. At the first time people thought that the stone breakwater constituent layers of protection should be using a large rock but with decreasing stone size then the construction of the breakwater and eventually switched to an artificial stone made of concrete and is formed in accordance with the concept of the author who finally discovered new facts that breakwater stability is not only determined by the weight of the stone but also largely determined by the interlocking of the rock, some rock layers progress protected latter include tetra pod, pod hex, dolos, A-Jack and many others. One type of construction layers protection thriving today is stone protection layer X-Block Produced by Marine Consultant in Europe, as well

as having a considerable weight has interlocking values are quite high, so that the stability of the construction of X-Blocks can be protected from attacks waves. Developments on the protection layer is a pretty good thing difficult To implemented in areas that lack the resources, manufacturing of concrete, and one of area that doesn't have adequate concrete material resources is East Kalimantan, so in general the concrete forming the base material imported from outside East Kalimantan, if stock file in the source reduce, it may increase prices in East Kalimantan. This has led to the selection of construction X-Block in East Kalimantan beaches experiencing erosion will be hard to implement because it will cost a very large, so in this research it's necessary to conduct further studies in order to use local materials for the manufacture of concrete and sand replenishment in stone protection layer breakwater can reduce the cost of implementing the construction of coastal protection in East Kalimantan.

Some previous researchers have developed the application of sand bags as coastal structures with ease Implementation considerations and reduce cost. Some researchers that have conducted on coastal protection with sandbags is (Silvesterdan @1992, Restall, @2002; Hornsey, @2003; Zhu., @2004; Shin @2007 ;), then continued research about the use of the material is on site work (Yuwono, @1992, Black, @2001) and in 2011 was publication by Ferry Fatnanta, with the title "Assessment transmission behavior and stability of the

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breakwater and sand bags emerged type". and construction has been implemented in some areas such as in the coastal district Handil, Samboja, Kutai Kertanegara regency in East Kalimantan. Handling the construction of coastal erosion using sacks filled with soil, which aims to reduces abrasion apparently, did not live long, then a few years later construction was damaged due the sacks that used is weathering and eventual construction of this no longer works optimally. Based on this, the authors are interested to develop a protected layer breakwater with concrete blocks serrated filled with sand. In this research, the authors developed protected layered concrete called beam-serrated, with this shape allows materials to enter the ground while casting before concrete casting execution, and use of formwork can be carried out repeatedly cause the formwork opening not need to distort the shape of the formwork.

## METHODOLOGY

### Concept of the prototype layer stone

The concept of protective stone breakwaters have been developed since World War II, there are several factors that affect the development include the size and the interlocking, then after developed further apparently other factors affecting stability are the placement and number of layers. Some rock layers are developing today as can be seen in the following figure:

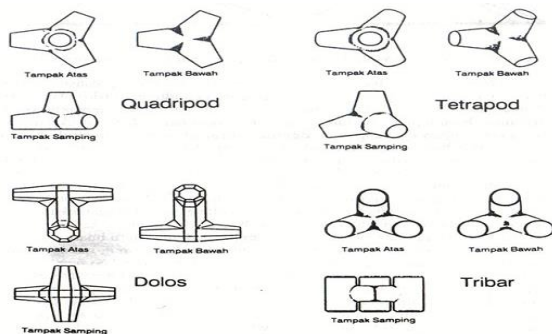


Fig 1. Shape Layers of Protection are Widely Used

In Figure 1 above all forms of Armor Layer Breakwater has a different KD value depending on the system, and the installation position. The placement of stone protection layer is divided into two ways, uniform and random. Uniform placement is generally used for the area that does not used feet construction or the construction isn't under water. Generally this placement is done near the coast and form homogeneous. While random placement is generally used in offshore waters that have influence of deep waters. Types of protective stone that is usually used on a random method must have

a high value of interlocking so can be locked as soon as the stone placed.

In generally the construction of breakwater has Armor Layer Breakwater as a protective of layer filter (filter layer) or other fine material, and serves to reduce the run-up and reflection on the waves. This protective stone usually consists of one or two layers, but Armor Layer Breakwater with serrated beam just have one layer, has advantages over the two layers, of which in addition to saving the cost and use of stone, it also saves the location of placement, mobilization and can avoid collapse due to overload.

The stability of the Armor Layer Breakwater of Breakwater can be achieved by making the Armor Layer Breakwater of breakwater remains in place although it has been hit by a wave, the factors affecting the stability of stone such a protective stone is heavy of rock, but the rock in the large size will lead to higher costs due to the need to create a concrete that has a large volume, and the second is the interlocking factors, that Armor Layer Breakwater of breakwater are locked to each other so became a single entity and this condition can defend itself from attack wave. Figure 2 illustrates the shape and breakwater protection layer that is commonly used in the construction of breakwater construction.

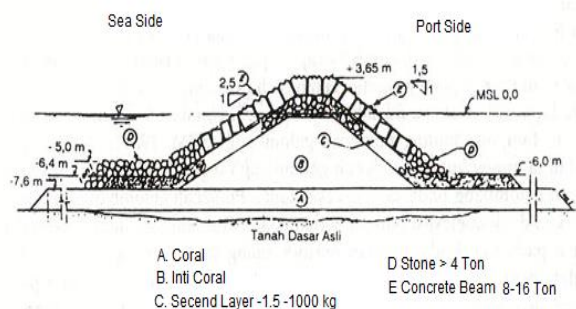


Fig. 2 Shape of Protective Layers of Breakwater

Heavy stone as a protection layer is calculated by the following Hudson formula:

$$W = \frac{\gamma_r H^3}{K_D (S_r - 1) \cot \theta} \quad (1)$$

Where:

$$W = \frac{\gamma_r (\text{Berat.Jenis.Batu.} 2,6t / m^3)}{\gamma_a (\text{Berat.Jenis.Air.Laut.} 1,02t / m^3)}$$

$$K_D = \text{Stability.of.Coeffisient}$$

### Concept of The Serrated Beam

Serrated beam is expected to be used on offshore protection, which focused on the placement of random and also structured, requires only a single layer of protective stone, it makes this Armor Layer Breakwater is similar to the protective layers stone with one layer protection which in general is very popular usage, remind it can make the construction costs down and still have the interlocking factors and believed to be economical implementation. Serrated beam is easy to implement and easy to achieve the level of stability because it can quickly occur interlocking well. Judging from the serrated beam shape is similar to X-base in which the bottom of part in the breakwater foot automatically can binding randomly and the implementation system is faster. In order to make use of local materials for the manufacture of Armor Layer Breakwater has been performed testing the concrete forming material with local-based and tested East Kalimantan do use sand and coral of East Kalimantan by using sand from the Mahakam and coral from Long Iram with compressive strength on plan K225 in 2012 by author et al, and the results of K250 concrete design using local materials were obtained composition East Kalimantan weight materials used for the manufacture of concrete as follows: water = 12,41; cement = 1.00, sand = 1.75, and coral = 3.83. To manufacture the concrete of serrated beam, has done experimental research method that is made in scale 1:10 to see the resilience of Armor Layer Breakwater due to the influence of sand content there in. And after the completion of casting done it hopes can be developed to test for assessing wave pool interlocking between the concrete blocks. In this study created a form of serrated beam with the advanced possibilities entering sand material into the layer of concrete beams protected. These are presented in figure serrated blocks that contain mostly sand.

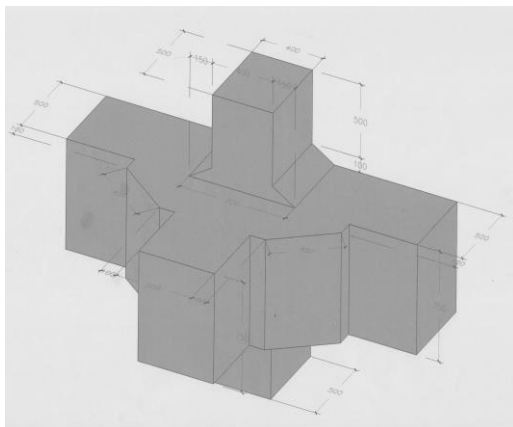


Fig.3 Prototype Layer Stone of Serrated Beam

### DISCUSSION

#### Production System of Armor Layer Breakwater

In this study the model and form of protective stone of breakwater has been design using special formwork that can be used repeatedly and the opening of formwork can be easily implemented without damaging the formwork. Another thing that was developed in this study is possible to enter the foundry sand bags into the Armor Layer Breakwater without the hassles and can be seen in Figure 4 below.

Entering sand bag into the Armor Layer Breakwater when casting surely give its own weakness in the Armor Layer Breakwater then this study will also assess the extent of the influence of sand bags on the strength of the Armor Layer Breakwater, so it will look in percentage of certain conditions of the Armor Layer Breakwater with serrated blocks form still can be allowed to be implemented. Filling sand bags in the Armor Layer Breakwater done at the foundry to implement, which begins with casting on the foot until it reaches  $\frac{3}{4}$ , then enter sandbags into the formwork and resumed casting, and so forth until the implementation is complete, so that with the completion of the implementation, the foundry sand component has been into the formwork. In figure 4, presents a form of execution in the construction of Armor Layer Breakwater with scale 1: 10.



a. Mold of concrete      b. Fill the sand to Mold



c. Open mold      d. Prototype Serrated Beam

Fig. 4 Filling Sand Method in Serrated Beam

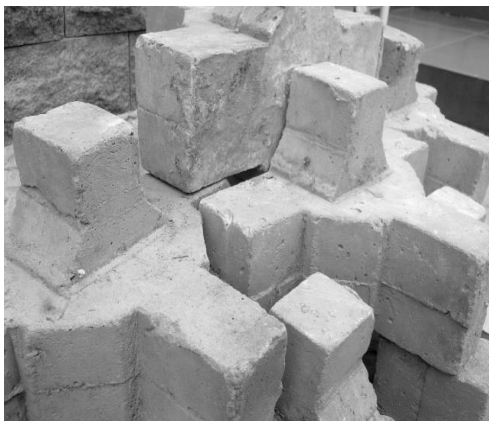
#### Development of Prototype Layer Stone

Tests were conducted in this study was limited to the manufacture of Armor Layer Breakwater concept that has teeth to obtain interlocking and manufacture form of

Armor Layer Breakwater may contain sand inside that is expected to reduce the components of concrete at the time of molding the stone, the second in this study will also there the stability test of the structure due to containing of sand in Armor Layer Breakwater to compare the strength of the Armor Layer Breakwater while still not containing components of sand yet and the Armor Layer Breakwater that has containing of sand and the final is test of arrange serrated beam Armor Layer Breakwater by random way or otherwise arranged for hope that can be obtained a guess when the installation at construction time implemented in a full scale, so the hassle factor in the building of the breakwater has considered well when the planning is done. In figure 5 below is shown picture of structure of Armor Layer Breakwater uniformly and randomly.



a. Uniformly Placed



b. Randomly Placed

Fig 5 The structure of placed system

At the structure of the Armor Layer Breakwater above shows interlocking between stones can occur when placed at random and placed in order. So thus Armor Layer Breakwater construction for breakwater

has been able to do a test on a wave pool with great variety.

### Strength of Serrated Beam

In this study also compared the ability of the Armor Layer Breakwater receives the load where the Armor Layer Breakwater without content of sand and Armor Layer Breakwater that are filled with sand can be seen in the following table and graph charts.

Table 1 Calculation of Concrete Compressive Strength

	Quality Plant		Extensi f Field cm2	Wight (gram)	Casting Date	Testing Date	Age Concret (hari)	Slump (cm)	Dial	
	Fck	Fc							KN	Kg
Armor without a mixture	K 225	18.68	32	3130	30-Aug-12	27-Sep-12	28	8	76	7747.20
Armor a mixture 10%	K 225	18.68	32	3108	30-Aug-12	27-Sep-12	28	8	65	6625.89
Armor a mixture 20%	K 225	18.68	32	3078	30-Aug-12	27-Sep-12	28	8	60	6116.21
Armor a mixture 30%	K 225	18.68	32	3064	30-Aug-12	27-Sep-12	28	8	60	6116.21
Armor a mixture 40%	K 225	18.68	32	3033	30-Aug-12	27-Sep-12	28	8	30	3058.10
Armor a mixture 50%	K 225	18.68	32	3011	30-Aug-12	27-Sep-12	28	8	10	1019.37
Armor a mixture 60%	K 225	18.68	32	3009	30-Aug-12	27-Sep-12	28	8	10	1019.37

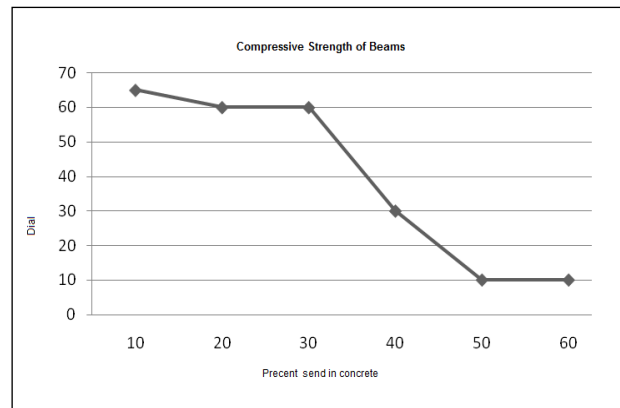


Fig. 6 Relationship between compressive strength and sand content in concrete beams

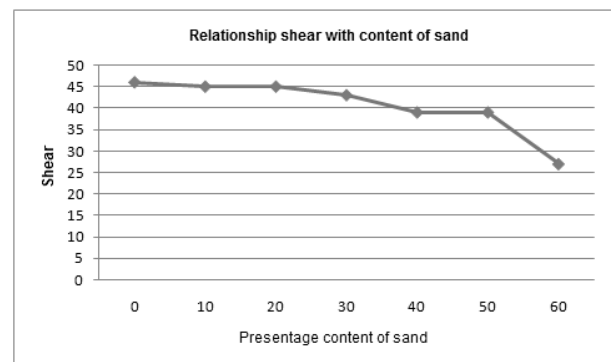
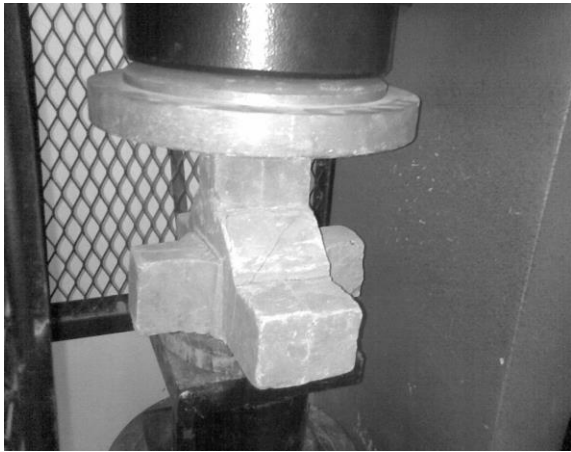


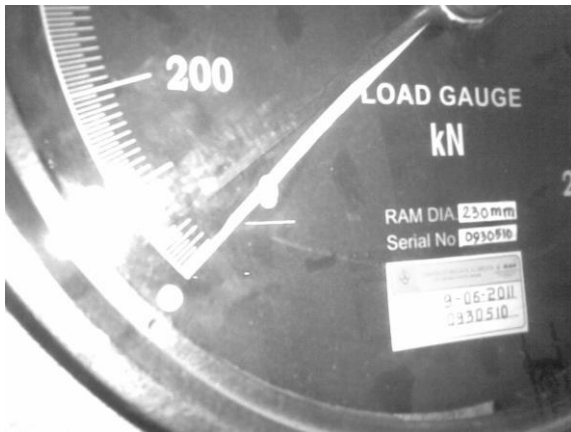
Fig. 7 Relationship between shear and content of sand in concrete beams



a. Pressure Machine Process



b. Serrated Beam Section Failure



c. Gauge Reading

Fig. 8. Serrated Beam Testing In Laboratory

From the graph above is shown that more content of sand that is owned by concrete blocks the ability of concrete blocks will decrease, and when sand content of

30%, then the condition of concrete beam is relatively more stable, although shear strength of his arm has decreased, but the arm sliding events are also still relatively better than the Armor Layer Breakwater that more than 30%, so it can be concluded that the use of sand in the Armor Layer Breakwaters are advised not to exceed 30% of the total volume of concrete in the serrated beams.

## CONCLUSION

1. The serrated beam concept with sand content basically can be developed to reduce the cost of implementation in areas which have problems of coastal erosion while concrete forming material resources are inadequate.
2. With the same shape capability of serrated beam filled sand in the content of 30% still showed the ability to support the load which is almost the same as concrete without sand.

## ADVICE

1. To determine the KD value in the serrated beams concrete need to be tested in the wave flume with various types of waves and breakwater slope
2. Needs to be studied further of serrated beam KD value due to the influence of the preparation of concrete beams associated with the put method.

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